HORSES GRAZING: POINT FUNCTION AND SHAPE

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Abstract:
The Horses Grazing site was located in the Sandhills near wetlands of the lower Little Crane Creek in eastern Moore County, North Carolina. It contained a full Holocene cultural sequence from Late Paleoindian-Early Archaic to Late Woodland. Of special interest is a component at the base of the cultural deposits that contains Big Sandy-Rowan projectile points. Rowan is one of at least three Big Sandy projectile point variants that occurs along the Atlantic Slope. We suggest that the variants may reflect a long-term northward movement of medium game hunters after the collapse of the megafauna ecology. They may have been following the northward movement of an isotherm associated with elk or bison. Forty-seven projectile points from the site provided limited samples of all of the usual types. A study of variation in the Guilford type indicated that they are scattered through the profile from Early Archaic to Early Woodland. Only the Guilford points with refined workmanship and round bases showed promise of being confined to the Middle Archaic. Projectile points were measured using an automated and bias-free system and analyzed to examine variations in outline shape. As has been found to be the case before, Palmer Corner-Notched and Kirk Corner-Notched were ambiguous in their distributions, but the Big Sandy variants were generally distinguishable.

Article:
Introduction
The Horses Grazing Site (31MR205) is located in eastern Moore County, North Carolina, northeast of Vass. It is on a sandy ridge that extends into wetlands along Little Crane Creek, a tributary of the Little River. The site was excavated during the winter of 2002–2003 under the sponsorship of the North Carolina Department of Transportation and in anticipation of rerouting Highway 1 from Sanford to Southern Pines around Cameron and Vass (Figure 1). More than 20,000 artifacts were recovered in 163 square meters. The assemblage included 47 mainly Archaic points, the primary topic of this article. This article is based on research initiated during the testing (Pertersen and Mohler 2002) and excavation (Gunn et al. 2003) of Horses Grazing, and has since been expanded by further analysis of artifacts and interpretations by the authors not presented in the technical reports.

Figure 1. Setting the datum at the Horses Grazing site (view to west).

Like many Sandhills sites, Horses Grazing initially veiled itself from archaeological eyes. In 1991, shovel testing during an early survey of the highway corridor produced only three rhyolite flakes (Lautzenheiser 1990). A subsequent visit by Robinson (1995) provided additional flakes. Finally, in 2001, after a decade, the site began to yield its secret. Excavation of a series of shovel tests at 20 meter spacing, and opening of six square meter units discovered both ceramic and Archaic horizons stratified to about 50 cm below the surface (NCDOT 2002; Petersen 2001; Petersen and Mohler 2002:105). Geochemical analysis of columns of sediment showed that there were phosphate residues from the Early Archaic and Woodland periods.

Benson (2000) explains the tentativeness of North Carolina Sandhills sites as a function of typical artifact density. As one follows artifact distributions in the Coastal Plain and Sandhills from Georgia to North Carolina, the overall site artifact densities tend to decline. One can excavate a 30-cm shovel test almost anywhere in a typical Georgia site and detect its presence; however, as one moves northeast through South and North Carolina, artifacts become clustered in concentrations frequently little more than a meter across. In a survey of the Fayetteville Outer Loop, this artifact density pattern presented itself in a powerful demonstration. Berry Williams, a surveyor for New South Associates, Inc., excavated a survey shovel test and was surprised to find nearly 100 flakes. Upon returning to test the site (31CD965), the excavation of two one-meter squares showed that the site consisted of over 700 artifacts from the working of a single rhyolite core within a meter of the original shovel test. If the lucky surveyor had placed his shovel test a meter away in any direction, he would have missed the site (Gunn and Sanborn 2002).

At the Horses Grazing site, Benson’s pattern also held true. Before the excavations began, a grid was laid out over a 64,000 square meter area (16 acres). Over 150 square meters were excavated, mostly in 5 x 5 m blocks. One one-meter square had as few as a four artifacts. In the northwest part of the site, a pattern of shovel tests placed 10 m apart turned up a concentration of 40 quartz flakes. When excavated, it proved to have over 2,500 artifacts in a small area no larger than two meters in diameter. Along with the many quartz and rhyolite flakes were cores, tools, and evidence of a fire and the collecting of hickory nuts (Gunn et al. 2003).

In the following sections of this article, we will discuss the excavation and stratigraphy of the Horses Grazing site. Then, the projectile points that were found will be evaluated in their functional and morphological dimensions. In a previous issue of North Carolina Archaeology, Drye (1998) pointed out that the study of point typology in the region has developed beyond the early impressions of shape or morphological consistency that Coe (1964) thought to be the case in his pioneering work on point typology in the Piedmont. The overlapping of point types reported by Drye in her analysis of point shapes and stratigraphy at Lowder's Ferry suggested to us that point function might be a key factor in understanding point typology of shapes. Some shapes are better suited to certain functions than others.

About 50 projectile points were recovered from Horses Gazing. This is not a large number compared to the many points found at Doerschuk (Coe 1964) or Lowder's Ferry (Drye 1998). On the other hand, sites densely packed with artifacts are not always the best places to study artifact function. As the senior author and colleagues have pointed out in another article (Gunn et al. 2002), artifact-scarce sites often open up the relationships between artifact types. In a more open distribution of artifacts, associations can be made between different functional types such as points, scrapers, burins, gravers, and utilized flakes. Also, as we shall see, there are efficient morphological ways to classify artifacts by function within types.

Setting

A citizen of North Carolina whose family has resided in the state since Colonial times once reported to the senior author that highways numbered less than 100 were old Indian trails. While this has yet to be verified in writing, Brooks (personal communication 1998) has discovered that Paleoindian sites in South Carolina tend to occur around pocosins near present-day interstate highways. This suggests that our current road system has ancient roots. In Moore County, North Carolina, U.S. Highway 1 passes over the first continuous, elevated pathway along the Sandhills that avoids the quagmires of wetlands typical of the Coastal Plain. Moore and Irwin (2002) have detected associations between Sandhills ridges and Early Archaic base camp sites. How does Horses Grazing fit into this picture? It is on a sandy ridge extending east from U.S. Highway 1. This ridge would have been a side road extending out into the food-rich wetlands of the lower Little River basin. The discovery of fish and turtle remains in the site support this inference.

The sandy ridge-end on which the site is located provides other amenities besides a food supply (Figure 2). Underneath the sand cap is a clay-rich, impermeable layer that supports a perched water table. Seramur reports the details of this geology in another article in this volume. The combination of springs seeping out from under the sand at the waterline around the low side of the ridge, and the dry, comfortable sand cap on which to camp, would have been additional, necessary features of the location for ancient inhabitants. Also present downstream a few hundred yards is a large quartz quarry that was once commercially exploited (J. Barnes, personal communication 2003). Seventy-eight percent of the Horses Grazing assemblage was quartz chipping debris (n=16,338).

While surveying sites on the Fayetteville Outer Loop, it became apparent that prehistoric people preferred to camp at places that were neither too steep nor too flat. This was probably because flat places would have been seasonal wetlands, even on the tops of hills, and steep places have obvious liabilities for living comforts (Gunn and Sanborn 2002). Examination of the microtopography of the Horses Grazing ridge revealed two areas that were likely resting places for the site's residents. One is on the ridge top (Ridge), and the other is on the north slope just above the spring (Platform). In these areas, the slope is about 2–4 degrees. The south side of the hill seems not to have been inhabited in spite of the presence of an inviting spring at the base of the moderate slope. This is probably because the southwest side of the hill was exposed to winds as is evidenced by a hollowed out area (Blowout).

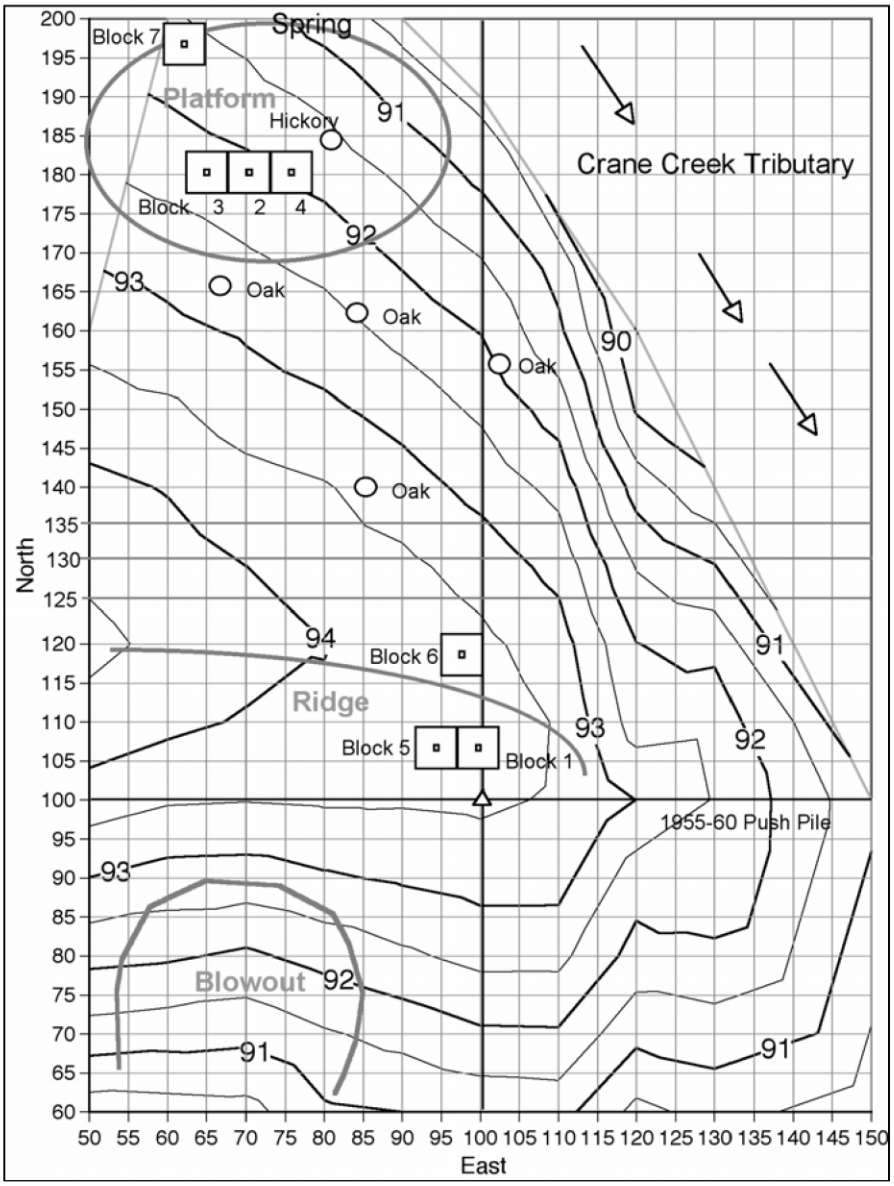

Figure 2. Contour map of the Horses Grazing site.

Excavating Horses Grazing

The excavation of Horses Grazing proceeded in six five-meter blocks (see Figure 2). The blocks were distributed to provide equal sampling of the two occupation-favorable areas of slope (i.e., three blocks in each). Additional microtopographic parameters were considered in the placement of the blocks within the Ridge and Platform areas. The design was intended to test a feedback relationship between the natural slope, or angle of repose, and human occupation. It became clear that human occupation tended to reduce slope angle by retarding wind, water, and human-induced erosion, and by introducing sediments in the form of lithic and food debris. The vertical geochemical characterization of the site begun by Petersen and Mohler was extended into a horizontal grid by taking samples in the southwest corner of each one meter square at the depth of greatest artifact concentration in each block (NCDOT 2002; Petersen 2001; Petersen and Mohler 2002).

Analysis of artifacts showed that the Ridge was most intensively occupied (Table 1). It produced 10,701 artifacts in the three complete blocks. Three blocks on the Platform returned 7,879 artifacts. However, keeping in mind Benson's pattern, the block on the Platform that produced the most artifacts, Block 7 (n=4,167), was of comparable scope to Block 5 (n=4,553) on the Ridge. The blocks that encountered concentrations produced nearly equal volumes of artifacts. The numbers of ceramics were not great; 115 were identifiable to ware and were concentrated in Blocks 1 and 4. They were generally confined to the upper 20–30 cm of the profile. Below ceramics were Archaic-age horizons. Only two Woodland stage points were found, a Pee Dee Pentagonal and an Eared Yadkin. Forty-five Archaic points were recovered from all periods. Judging by the stratigraphy, the proportion of Woodland-to-Archaic artifacts probably does not reflect the amount of activity in the two periods. The feedback between human occupation and slope diminishment was much more intense in the Woodland than in the Archaic. A high degree of Woodland activity is not unreasonable given that the Cameron Mound (Irwin et al. 1999; MacCauley 1966) is only about three kilometers to the east. This accretional mound with Hopewell-like artifacts such as copper beads suggests that there was some amount of organization of human labor in exploitation of the eastern Moore County wetlands during the Woodland. Local tradition holds that an important Native American trail, later the Yadkin Road and plank road passed through the Little River

Table 1. Prehistoric Artifact Types by Block and Landform.

Artifact Types	Blk. 1 Ridge	Blk. 5 Ridge	Blk. 6 Ridge	Blk. 9 Ridge	Blk. 2 Platform	Blk. 3 Platform
Cape Fear Series	16	7	1	3	11	0
Hanover Series	10	1	0	0	1	0
New River Series	1	3	0	0	2	0
Thom's Creek	0	0	0	0	1	0
Yadkin Series	1	1	3	0	0	0
UID Sherd	14	0	0	0	3	0
Daub	3	0	0	0	0	0
Ceramics Subtotal	45	12	4	3	18	0
Percent	32	9	3	2	13	0
Big Sandy	4	1	1	0	0	0
Eared Yadkin	1	0	0	0	0	0
Guilford Crude Round	0	1	0	0	1	0
Guilford Crude Straight	0	2	0	0	1	1
Guilford Refined Round	0	0	0	0	0	0
Guilford Refined Straight	1	0	0	0	0	0
Kirk Corner Notched	1	0	0	0	0	0
Kirk Knife	0	0	0	0	0	1
Kirk Serrated	1	0	0	0	0	0
Morrow Mountain	3	1	0	2	2	0
Pee Dee Triangular	0	1	0	0	0	0
Savannah River	1	3	0	1	1	0
Savannah River Small	1	1	0	0	0	0
Stanly	0	0	0	1	0	0
Point Subtotal	13	10	1	4	5	2
Percent	28	21	2	9	11	4
Base	2	1	1	0	0	1
Mid	2	0	0	0	0	0
Tip	6	0	1	0	2	0
Tip Knife	0	2	0	0	0	0
Tip Projectile	0	1	0	0	1	0
Point Fragment Subtotal	10	4	2	0	3	1
Percent	45	18	9	0	14	5
Burin	0	0	0	1	0	0
Burin Dihedral	0	0	1	0	0	0
Burin Spall	0	0	0	0	0	0
Drill Shaft	0	0	0	0	0	0
Flake Retouched	6	5	12	7	6	5
Flake Tertiary Utilized	5	9	6	3	3	4
Graver-Notch-Scraper	0	0	0	0	0	0
Hammerstone	8	7	1	0	0	1
Morrow Mountain Drill	0	0	0	0	0	0
Notch	2	0	2	0	2	0
Scraper	14	4	3	2	8	2
Scraper Circular	0	0	0	0	1	0

Table 1 continued.

Artifact Types	Blk. 1 Ridge	Blk. 5 Ridge	Blk. 6 Ridge	Blk. 9 Ridge	Blk. 2 Platform	Blk. 3 Platform
Scraper End	0	0	1	0	0	0
Scraper End Palaeoindian	0	0	0	0	0	1
Scraper End/Side	0	0	1	1	0	0
Scraper Paleoindian Fluted	0	0	1	0	0	0
Scraper Side	2	0	1	0	0	0
Tool Subtotal	37	25	29	14	20	13
Percent	15	10	12	6	8	5
Biface	1	0	2	0	1	1
Biface Frag	17	16	10	7	5	9
Chopper	0	1	1	0	1	0
Core Bifacial	0	0	0	0	0	0
Flake Bifacing	346	826	100	136	309	58
Flake Bifacing Burned	0	0	0	0	8	0
Biface Flaking Subtotal	364	843	113	143	324	68
Percent	11	26	3	4	10	2
Blade	1	0	0	0	0	0
Blade Flake	2	1	0	1	1	0
Core	18	29	40	6	10	5
Core Frag	14	0	6	2	2	1
Core Frag Burned	0	1	0	0	0	0
Core Micro	0	0	0	0	0	1
Core Micro Prismatic Blade	0	0	0	0	1	0
Core Prismatic	0	1	0	0	0	0
Core Rejuvenation Flake	0	2	0	0	0	1
Flake Primary	0	8	3	0	1	1
Flake Primary Utilized	0	0	0	0	0	0
Flake Secondary	22	20	3	4	15	6
Flake Secondary Burned	0	0	0	0	1	0
Flake Secondary Retouched	1	0	0	0	0	0
Flake Tertiary	775	843	629	289	576	646
Flake Tertiary Burned	0	1	0	0	14	0
Flake Tertiary Retouched	2	2	0	1	0	0
Shatter/Chunk	778	902	356	197	223	281
Core Flaking Subtotal	1,613	1,810	1,037	500	844	942
Percent	16	18	10	5	8	9
Fire Cracked Rock	314	71	3	99	48	11
Iron Concretion	264	162	112	58	12	10
Iron Concretion Burned	1	0	0	1	2	1
Unmodified Stone	993	1,614	1,183	190	227	119
Boiling Stone Subtotal	1,572	1,847	1,298	348	289	141
Percent	23	27	19	5	4	2
Diabase Fragment	1	0	0	0	0	0
Granite	1	0	0	0	0	0
Petrified Wood	2	0	0	0	0	0

Table 1 continued.

Artifact Types	Blk. 1 Ridge	Blk. 5 Ridge	Blk. 6 Ridge	Blk. 9 Ridge	Blk. 2 Platform	Blk. 3 Platform
Red Ochre	0	0	0	0	0	0
Bone	0	1	0	0	0	0
Charcoal Fragments	4	0	0	0	0	0
Fish Scale	1	0	0	0	0	0
Turtle Shell	1	0	0	0	0	0
Total	3,664	4,553	2,484	1,012	1,505	1,167
Percent	17	22	12	5	7	6

Table 1 continued.

Artifact Types	Blk. 4 Platform	Blk. 7 Platform	Blk. 8 Platform	STP Platform	Total
Cape Fear Series	26	2	0	0	66
Hanover Series	5	0	0	0	17
New River Series	0	0	0	0	6
Thom's Creek	0	0	0	0	1
Yadkin Series	18	2	0	0	25
UID Sherd	4	0	0	0	21
Daub	0	0	0	0	3
Ceramics Subtotal	53	4	0	0	139
Percent	38	3	0	0	
Big Sandy	0	0	0	0	6
Eared Yadkin	0	0	0	0	1
Guilford Crude Round	1	1	0	0	4
Guilford Crude Straight	0	0	1	0	5
Guilford Refined Round	2	0	0	0	2
Guilford Refined Straight	0	2	1	0	4
Kirk Corner Notched	0	0	0	0	1
Kirk Knife	0	0	0	0	1
Kirk Serrated	0	1	0	0	2
Morrow Mountain	0	2	0	0	10
Pee Dee Triangular	0	0	0	0	1
Savannah River	0	0	0	0	6
Savannah River Small	0	0	0	0	2
Stanly	1	0	0	0	2
Point Subtotal	4	6	2	0	47
Percent	9	13	4	0	
Base	0	0	0	0	5

Table 1 continued.

Artifact Types	Blk. 4 Platform	Blk. 7 Platform	Blk. 8 Platform	STP Platform	Total
Mid	0	0	0	0	2
Tip	0	2	0	0	11
Tip Knife	0	0	0	0	2
Tip Projectile	0	0	0	0	2
Point Fragment Subtotal	0	2	0	0	22
Percent	0	9	0	0	
Burin	1	0	0	0	2
Burin Dihedral	0	0	0	0	1
Burin Spall	0	3	0	0	3
Drill Shaft	1	0	0	0	1
Flake Retouched	3	34	5	1	84
Flake Tertiary Utilized	10	16	2	0	58
Graver-Notch-Scraper	0	1	0	0	1
Hammerstone	0	1	0	0	18
Morrow Mountain Drill	0	1	0	0	1
Notch	0	2	1	0	9
Scraper	5	11	0	1	50
Scraper Circular	0	0	0	0	1
Scraper End	0	0	0	0	1
Scraper End Palaeoindian	0	1	0	0	2
Scraper End/Side	0	1	0	0	3
Scraper Paleoindian Fluted	0	0	0	0	1
Scraper Side	0	4	0	0	7
Tool Subtotal	20	75	8	2	243
Percent	8	31	3	1	
Biface	2	0	0	0	7
Biface Frag	10	28	4	0	106
Chopper	0	0	0	0	3
Core Bifacial	0	1	0	0	1
Flake Bifacing	637	665	36	13	3,126
Flake Bifacing Burned	0	0	0	0	8
Biface Flaking Subtotal	649	694	40	13	3,251
Percent	20	21	1	0	
Blade	0	0	0	0	1
Blade Flake	0	3	0	0	8
Core	27	31	0	2	168
Core Frag	0	13	1	0	39
Core Frag Burned	0	0	0	0	1
Core Micro	0	1	0	0	2
Core Micro Prismatic Blade	0	0	0	0	1
Core Prismatic	0	0	0	0	1
Core Rejuvenation Flake	0	1	0	0	4
Flake Primary	18	3	1	0	35
Flake Primary Utilized	0	1	0	0	1

Table 1 continued.

Artifact Types	Blk. 4 Platform	Blk. 7 Platform	Blk. 8 Platform	STP Platform	Total
Flake Secondary	12	12	6	1	101
Flake Secondary Burned	0	0	0	0	1
Flake Secondary Retouched	1	1	0	0	3
Flake Tertiary	271	2,295	94	26	6,444
Flake Tertiary Burned	7	1	0	0	23
Flake Tertiary Retouched	0	5	1	1	12
Shatter/Chunk	325	383	9	18	3,472
Core Flaking Subtotal	661	2,750	112	48	10,317
Percent	6	27	1	0	
Fire Cracked Rock	26	28	7	0	607
Iron Concretion	48	51	1	0	718
Iron Concretion Burned	1	0	0	0	6
Unmodified Stone	743	459	30	1	5,559
Boiling Stone Subtotal	818	538	38	1	6,890
Percent	12	8	1	0	
Diabase Frag	0	0	0	0	1
Granite	0	0	0	0	1
Petrified Wood	0	0	0	0	2
Red Ochre	0	1	0	0	1
Bone	0	0	0	0	1
Charcoal Fragments	0	43	0	0	47
Fish Scale	0	0	0	0	1
Turtle Shell	0	0	0	0	1
Total	2,207	4,167	200	64	20,964
Percent	11	20	1	0	

basin between the Cape Fear and the Yadkin-Pee Dee rivers (Oates 1981). This could account for some of the traffic through the area.

Occupation at Horses Grazing began in the Late Pleistocene (13,000– 10,000 B.P.) or Early Holocene (10,000–8,000 B.P.). Six of the points were of a Big Sandy variety defined by Cooper (1970) as Rowan. Big Sandy is a side-notched point that was defined west of the Appalachians where it has a wide morphological variation (Lewis and Lewis 1961). At Stanfield-Worley Rock Shelter (Futato 1996) and Dust Cave (Driskell 1996), it appears immediately after Dalton and has a tool kit of scrapers, burins, gravers, and prismatic blades identical to Dalton. Along the Atlantic Slope, three variants have been recognized. In South Carolina south of the Santee River, the Taylor type is identified (Charles 2003; Michie 1971; 1996). At the Big Pine Tree site (38AL143) in Allendale County, Taylors are stratified with or above Dalton, and at the Topper site (38AL23) they occur directly over Clovis (Goodyear 2001, 2003). North of the Santee River the Rowan variant is found through the Sandhills from the upper Pee Dee River (Charles 2003) to the southern tier of counties in Virginia where it has a distinctly "intrusive" cultural character (McAvoy and McAvoy 1997:183). Cooper (1970) used Rowan projectile points from Granville County in his type description (specimens B, C, D, and F). McAvoy (personal communication 2003) believes that Granville and Wake counties may be the area of greatest concentration of Rowan points. Cooper's specimens A and E are from Rowan County in the upper Piedmont. Robinson (personal communication 2003) has also found Rowan points in the upper Yadkin River drainage in the Wake Forest University Museum collections. As will be discussed in the section on point morphology, Rowan points are frequently classified as Kirk Corner- Notched in North Carolina sites, as Cooper pointed out in his type definition. Along the Nottaway River in Virginia, the Rowan variant is replaced by, or slightly overlaps with, Fort Nottaway side-notched (McAvoy and McAvoy 1997:183). Like the Taylor and Big Sandy points, Fort Nottaway is associated with a Dalton-like tool kit, but unlike those types, Fort Nottaway points have been dated to after Kirk at about 8,900– 8,800 B.P (McAvoy and McAvoy 1997:183).

The dating of Rowan is in question as no precise dates were found at Horses Grazing or any other excavated site. An interesting question is whether Rowan in North Carolina dates before Kirk as in South Carolina or after Kirk as in Virginia. Evidence from Horses Grazing may indicate before. On a site-wide basis, there are no distinct stratigraphic transitions from Rowan to Kirk (Table 2), which is to say they do not occur in the same Blocks. Correlating depths across blocks is a problem since the deepest levels in Block 6 are shallower than those in Block 5. However, the Rowan specimen that is most clearly in place is in Block 6, and it is associated with Paleoindian tools, while the Kirk specimens in Blocks 3 and 7 appear to be more closely allied with the Morrow Mountain strata. Daniel (2002:8) has obtained a date of 8,940 ± 70 on a level under Kirk at Barber Creek. No diagnostics have yet appeared from the level, but future developments should prove of value to the question of Rowan dating.

At the Taylor Site, Michie (1996:243) notes that the early components tend to be scattered over the entire 35 acres of the site while later ones are concentrated in distinct loci. Though a much smaller site (16 acres), Horses Grazing has a similar pattern. All of the Rowan points were found in Blocks 1 and 5 on the Ridge. Other tools characteristic of Paleoindian, however, were found in a thin but uniform distribution through all of the

Table 2. Sitewide Transition Matrix Analysis of Temporally Diagnostic Artifacts.

Period	Point	1	2	3	4	5	6	7	8	9	Total	Error	%Error
Paleo	1-Paleo	7	4	0	0	1	1	0	0	0	13	2	1.8
Archaic	2-Rowan	0	0	3	0	0	1	0	0	0	4	1	0.9
	3-Kirk	0	0	0	1	2	1	0	0	0	4	3	2.7
	4-Stanly	0	0	0	0	1	0	0	0	0	1	0	0.0
	5-MMtn	0	0	0	0	7	3	1	0	0	11	1	0.9
	6-Guilford	2	0	0	0	0	8	3	1	1	15	4	3.6
Ceramic	7-Sav-Tc[a]	0	0	0	0	0	0	3	3	1	7	1	0.9
	8-NR-CF-Arrow[b]	0	0	0	0	0	0	0	13	4	17	0	0.0
	9-Han-Arrow[c]	4	0	1	0	0	0	0	0	34	39	5	4.5
	Total										111	17	15.3

Key:

Transition to Same Period

Transition to Expected Period

Out of place (low)

Out of place (high)

a Savannah River-Thom's Creek
b New River-Cape Fear-Eared Yadkin
c Hanover-PeeDee Pentagonal

blocks both on the Ridge and Platform. They include formal scrapers, burins, gravers, and prismatic blade technology. One of the characteristics of the Fort Nottaway point is fluting of one side to thin the base. A biface fluted on one side was found with the Block 6 Rowan occupation. Does this suggest a linear connection with Fort Nottaway?

One would gather from Drye's analysis of point morphology distributions at the Lowder's Ferry site that the early Holocene/Early Archaic points are relatively discrete types. As the sequence progressed into Morrow Mountain, Guilford, and Savannah River, the discreteness is muddied by inter-stratification of types. This may be due to the types being used at the same time for different functions, or it may be the result of resharpening. Resharpening of Morrow Mountain or Savannah River points, for example, could yield so-called Guilfords. Guilfords are the natural catchall category for anything from "gray-area" preforms to well- worked bifaces. Both Coe (1964:43) and Drye (1998:57) point out that there is internal variation within the type that includes straight and round bases. In the Horses Grazing analysis, this shape inventory was extended

Table 3 continued.

Chronology	Type	15	20	25	30	35	40	45	50	55	Total
		Depth cmbs Top									
9	Hanover Fabric 4 Sand	1	0	0	0	0	0	0	0	0	1
9	Hanover Grog	1	1	0	0	0	0	0	0	0	2
9	Hanover Plain Grog	0	0	0	1	0	0	0	0	0	1
9	Pee Dee Triangular	0	1	0	0	0	0	0	0	0	1
	Total	30	24	21	10	14	7	1	2	2	111

- Main Focus
- Outliers

Table 3. Temporal Diagnostics for Transitional Probability Analysis.

Chronology	Type	15	20	25	30	35	40	45	50	55	Total
		Depth cmbs Top									
1	Burin	0	0	1	0	0	0	0	1	0	2
1	Burin Dihedral	0	1	0	0	0	0	0	0	0	1
1	Burin Spall	0	0	1	0	1	1	0	0	0	3
1	Core Micro	0	0	0	0	1	1	0	0	0	2
1	Core Micro Prismatic Blade	0	0	0	1	0	0	0	0	0	1
1	Core Prismatic	0	1	0	0	0	0	0	0	0	1
1	Scraper End Paleoindian	0	0	0	0	0	1	0	0	0	1
1	Scraper End Plaeoindian	0	0	0	0	0	0	0	1	0	1
1	Scraper Paleoindian Fluted	0	0	0	0	0	1	0	0	0	1
2	Rowan	0	1	1	0	1	1	0	0	0	4
3	Kirk Coner Notched	1	0	0	0	0	0	0	0	0	1
3	Kirk Knife	0	0	0	0	0	1	0	0	0	1
3	Kirk Serrated	0	0	1	0	1	0	0	0	0	2
4	Stanly	0	0	1	0	0	0	0	0	0	1
5	Morrow Mountain	3	0	2	2	3	0	0	0	0	10
5	Morrow Mountain Drill	0	0	0	0	1	0	0	0	0	1
6	Guilford Crude Round	0	1	1	1	0	1	1	0	0	5
6	Guilford Crude Straight	0	2	1	0	1	0	0	0	1	5
6	Guilford Refined Round	0	0	0	0	2	0	0	0	0	2
6	Guilford Refined Straight	0	1	1	0	1	0	0	0	0	3
7	Savannah River	2	1	2	0	1	0	0	0	0	6
7	Savannah River Small	0	1	0	0	0	0	0	0	0	1
8	Eared Yadkin	0	1	0	0	0	0	0	0	0	1
8	New River Cord 1	1	0	0	0	0	0	0	0	0	1
8	New River Fabric 2	1	0	0	0	0	0	0	0	0	1
8	New River Punc	0	1	0	0	0	0	0	0	0	1
8	Thom's Creek Plain	0	0	1	0	0	0	0	0	0	1
8	Yadkin Cord 1	0	1	0	0	0	0	0	0	0	1
8	Yadkin Cord 1 Amphiblolite	0	0	1	0	0	0	0	0	0	1
8	Yadkin Cord 1 Quartz	1	0	0	0	0	0	0	0	0	1
8	Yadkin Cord 4	0	1	0	0	0	0	0	0	0	1
8	Yadkin Fabric 2 Granite	1	1	0	0	0	0	0	0	0	2
8	Yadkin Fabric 4 Granite	1	0	2	0	0	0	0	0	0	3
8	Yadkin Granite	2	0	0	1	0	0	0	0	0	3
9	Cape Fear	0	2	0	1	1	0	0	0	0	4
9	Cape Fear Cord 1	2	0	1	1	0	0	0	0	0	4
9	Cape Fear Cord 2	6	1	1	0	0	0	0	0	0	8
9	Cape Fear Fabric 2	0	0	0	1	0	0	0	0	0	1
9	Cape Fear Fabric 4	4	4	3	0	0	0	0	0	1	12
9	Cape Fear Fabric 5	1	0	0	0	0	0	0	0	0	1
9	Hanover Fabric 2 Grog	0	1	0	1	0	0	0	0	0	2
9	Hanover Fabric 4 Grog	2	0	0	0	0	0	0	0	0	2

by including the straight and round base distinctions along with crude and refined workmanship. Fifteen Guilfords *senso lato* were recovered (Table 3). Of these, only the Guilford refined straight base was confined to a single depth horizon at a Middle Archaic depth. The other varieties (Guilford refined straight base, Guilford crude straight or round base) occurred from Early Archaic to Early Woodland levels. As is normal with small samples, the findings yield a relatively qualitative result—that is, they are hypotheses for further research.

There is evidence that the Middle Archaic was an active time at Horses Grazing. The largest number of points (n=10) is of the Morrow Mountain type. Kirk, Stanly, and Savannah River comprise lesser proportions of the assemblage. The Guilford evidence was inconclusive from a projectile point perspective as discussed above. However, the only visible evidence of stratigraphy in the entire site was a dark stain in Block 7 between 35–40 cmbs. It was about two meters across and appeared to be at the same horizon as the large accumulation of lithics in the northwest corner of the bock mentioned earlier. The lithics were associated with a Guilford refined straight base. Guilford points of other varieties appeared above and below the stain. Geochemical and archaeobotanical analyses did not reveal anything special about the stain. It may have been a Guilford living floor with human activity increasing the organic content. Though short of diagnostics, the associated high concentration of artifacts, and the similarly positioned highest vertical concentration of artifacts across the site, imply an intense but ill-marked period of activity during the Guilford and/or Morrow Mountain periods. A similar period of intense activity has been identified at other sites such as Lowder's Ferry (Drye 1998).

Organizing Points by Functions

Tool function is perhaps the oldest topic of conversation in archaeology. It was taken for granted in early archaeological writings of the nineteenth century. In the mid-twentieth century, such categories were questioned for a time, only to be reinstated by intensive new forms of analysis pioneered by Semenov (1973) and Keeley (1980). While extremely convincing when carried out in the context of double-blind experiments, these techniques required extensive experimental replication and analysis of artifact surfaces at time-consuming high microscopic resolution.

Under the demands of analyzing large numbers of artifacts in constrained time windows, the possibility of being able to detect artifact function through morphology has been of interest to us for the last few years. While we do not adhere to the belief that tools can be satisfactorily analyzed in broad categories simply as projectile points and scrapers, we do think that careful attention to form and breakage add sufficient detail to subdivide gross artifact forms into narrower and more realistic functional types, though not as narrow as the high-resolution microscopic/replicative analyses. Macroscopic and low-resolution microscopic wear analysis can also be both efficient and helpful. When this neotypology is supplemented with materials and spatial distributions, both within and between sites, it often becomes clear what the makers and users of prehistoric tools intended to do with them. The methodology allows the practical archaeologist to take advantage of many insights gained from intensive replicative wear studies, such as those performed by Keeley, but at the same time process a large array of artifacts in a timely manner.

Points have given the most direct access to this technique. Differences in haft length are evident in Archaic points, and they are frequently either directly or indirectly the subject of analysis. The evidence suggests that points were carefully engineered to serve at least two purposes. It is well understood that so-called "projectile points" served as both projectile points and knives, so much so that the acronym PPK, projectile point-knife, is commonly applied. Hence, there are points as a class, and subclasses of points can be either projectile points or knife points. (Are there other such classes?)

If one examines the tips of unbroken points, it becomes readily evident which is which. Some have carefully prepared, sharp tips. These would be projectile points. Others have round, blunt, unprepared tips that certainly could not penetrate a hide and are likely candidates for knives.

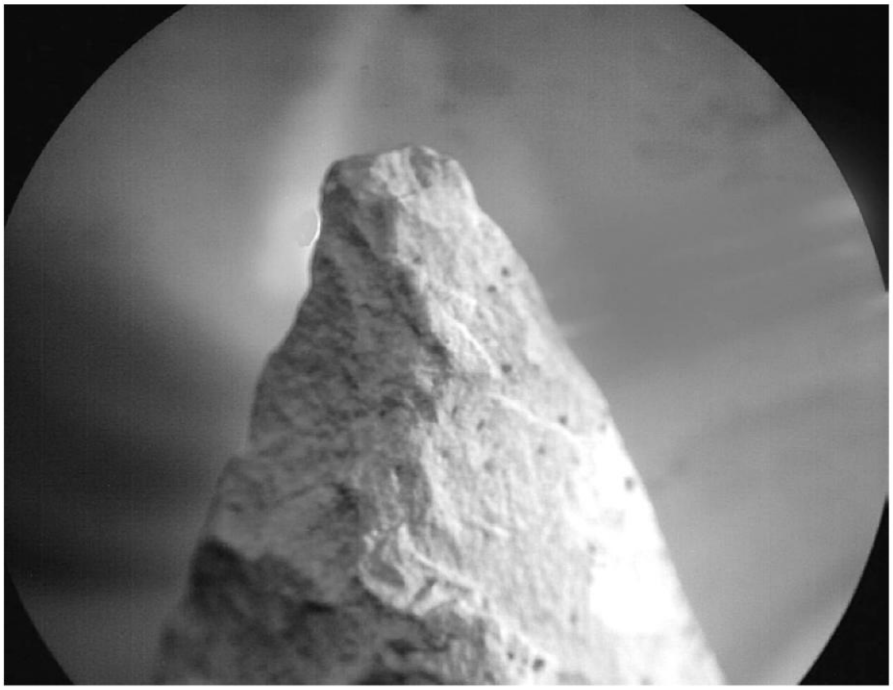

Figure 3. Microphotograph of a Rowan shafted tip (specimen #830).

Examples can be seen in the points that Cooper (1970) used as a type collection for the Rowan type. Of the six points, the upper three have round and blunt tips. If attached to atlatl shaft and propelled toward a thick-skinned animal, they would have bounced off rather than penetrated. The lower three points bear sharp tips. Sharp-tipped specimens dominated the Rowan assemblage at Horses Grazing. A microphotograph of a Rowan tip (Figure 3) shows that the tip was carefully prepared by the removal of nearly-microscopic pressure flakes from either side. The tip was then slightly ground. It is a well-known technique among flint knappers that slight grinding of a sharp edge reduces the likelihood of the edge shattering on impact. At Horses Grazing, these sharp, or shafted we will say, tips appear in subsequent generations of points such as Stanly, Morrow Mountain, and Pee Dee. The continuation of the shafted tip technique through the whole of the Holocene underscores its great utility in the preparation of projectile point tips. One of the benefits of this analysis is that point tips, which are frequently found in sites, can enter the analysis on an equal footing with whole points.

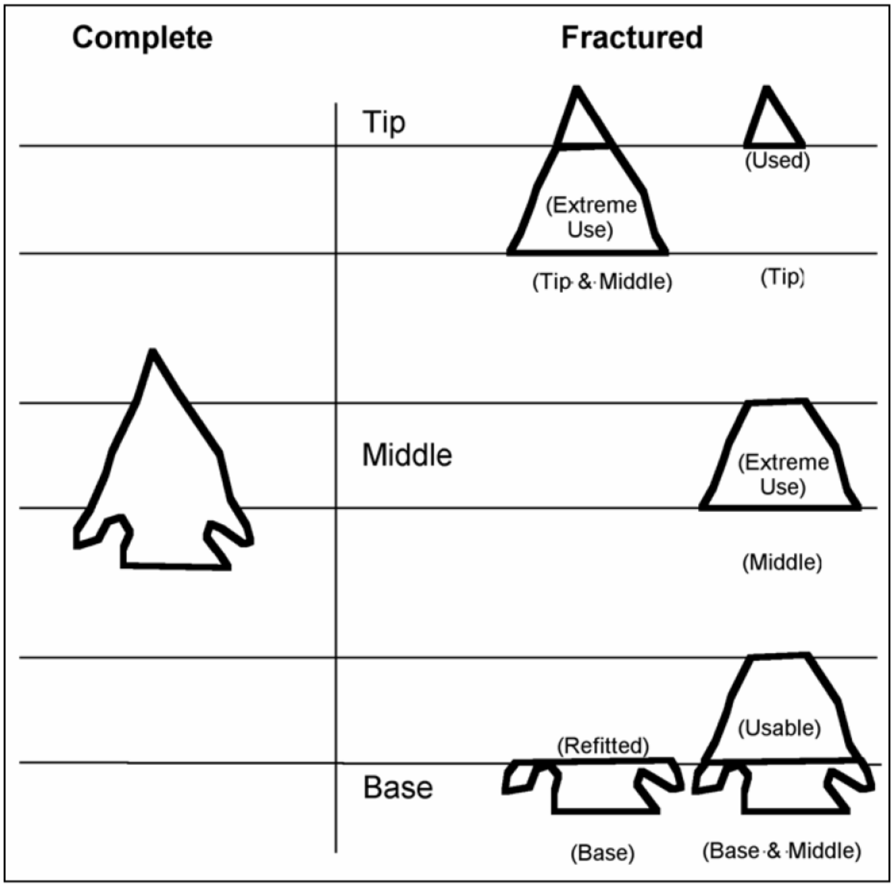

Figure 4. Point breakage classification.

This sort of analysis of tips can be extended to the middle and base segments of points. Are the edges of the mid section blunted or backed, or are they sharp and serrated? Did frequent resharpening lead to beveling? As with tips, breakage simply adds more information rather than removing a point from analytical consideration. We assume that if the tip of a point is broken, it occurred during impact, usually detectable by characteristic impact fractures or by light knife work (Figure 4). If a mid section is found, it suggests that the point continued in knife-use after the tip was broken in a situation ill-suited for rehafting. This could be during the immediacy of butchery away from base camp. It also implies extremely vigorous use of the remnant point. If a haft is found, it suggests the more

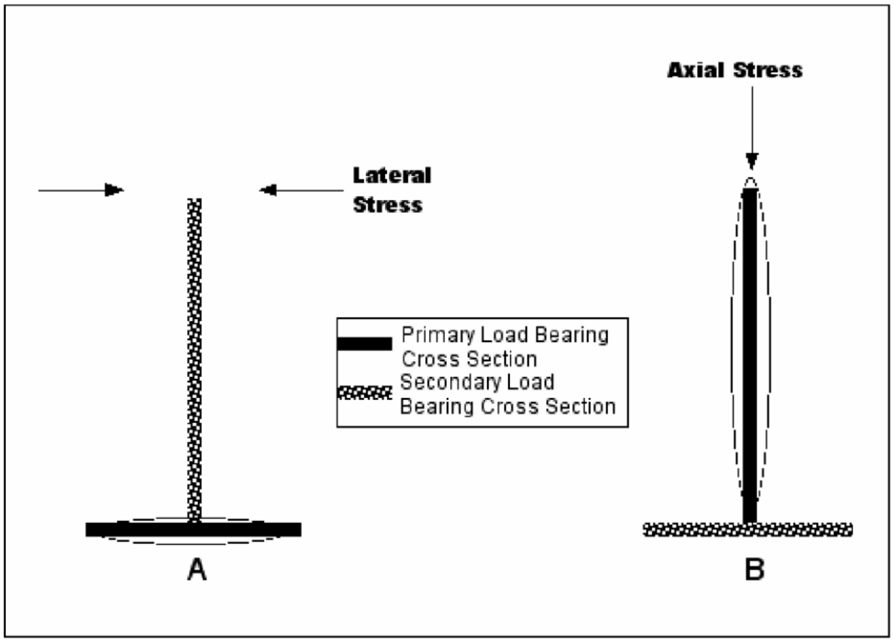

Figure 5. Load model of point function (adapted from Gunn and Kerr 1984:136).

relaxed conditions such as a base camp where time allowed implements to be re-hafted at leisure.

A load model helps to visualize the interaction of form, breakage, and refabrication. The knife and projectile functions impose different kinds of stresses on points. In terms of the stress borne in use, a projectile point receives end-on or axial stress upon impact (Figure 5). It must be designed to absorb that stress and disperse it to its haft—a spear or dart—in a manner that does not weaken or destroy the haft (Gunn and Brown 1982:245; Gunn and Kerr 1984:136). The common solutions to this problem included making the base relatively wide, and blunting the basal edge with grinding. Interestingly, basal grinding occurs in all periods at Horses Grazing, although it is less frequent in the latter periods. Undoubtedly plastic glues were also applied to disperse energy. Steve Watts (personal communication 1995) believes that a similar effect was achieved with Morrow Mountain points by melting or "shrink wrapping" them into cane hafts.

A knife point bears a different kind of stress. Most of the pressure it receives arises from sideways or lateral pressure during cutting. This lateral stress tends to twist the point in the haft. Managing this stress was approached through lengthening the haft. This could be accomplished by adding a stem to the base of a point, or by extending the notches up the sides of the point. The stem or side notches would be bound inside or supported by more flexible material such as wood or bone, which also served as a handle.

The study of notches and stems is always a fulcrum of controversy in point classification. This is evident in Daniel's (1998:60) discussion of the Palmer and Kirk points. He reports that Palmers and Kirks are distinguished at the Research Laboratories of Archaeology at UNC by plotting the tang length, the distance from the base to the top of the notches, against the tang width, the distance across the notches. In this distribution, the Palmer and Kirk types overlap in a subtle gradation (Figure 6). The whole corner-notch and side-notch problem can be thought of as a gradation in which the notches rotate around the corners of the base from corner to side (Gunn and Prewitt 1974). For that matter, stems can be thought of as large corner notches. The tang length also defines the length of the base or, in terms of physical mechanics, the load arm of the knife. In the case of the Palmer, the load arm is very short, leading one to suspect that it is a projectile point. In the case of Kirk, the load arm is longer, suggesting that it is a knife. For Big Sandy and its variants, this model can be extended by thinking of the load arm as reaching further up the blade. This is accomplished by chipping longer notches up the side of the blade. As can be seen in Figure 6, the effect of the broad Big Sandy-Rowan notches is to move their distribution to the right of Kirk on the plot. The next question is, why would a point that has obvious qualities of a projectile such as shafted tips, have such a long load arm?

For people on the move, as the Early Holocene Paleoindian and Early Archaic point manufacturers, a priority would have been to reduce the number of implements they were required to carry, the so–called “curated” technology (Goodyear 1989). This could have been accomplished by broadening the function of points to both knife and projectile capabilities. The Big Sandy and Stanly points at Horses Grazing have a combination of sharp tips and long hafts, one by long side notches and the other by adding a stem. There is an interesting morphological difference between the Big Sandy-Taylor points of southern South Carolina and the Rowan points. As can be seen in Figure 6, the Taylors plot in stem length among the shorter notched Kirks. The Big Sandy points from Horses Grazing, and especially the Swamp site (31CD876) specimen, plot well beyond Kirks. Can this be taken to imply that the Rowans were made for a more mobile situation? Perhaps the Fayetteville area of the Sandhills was traveled into as a

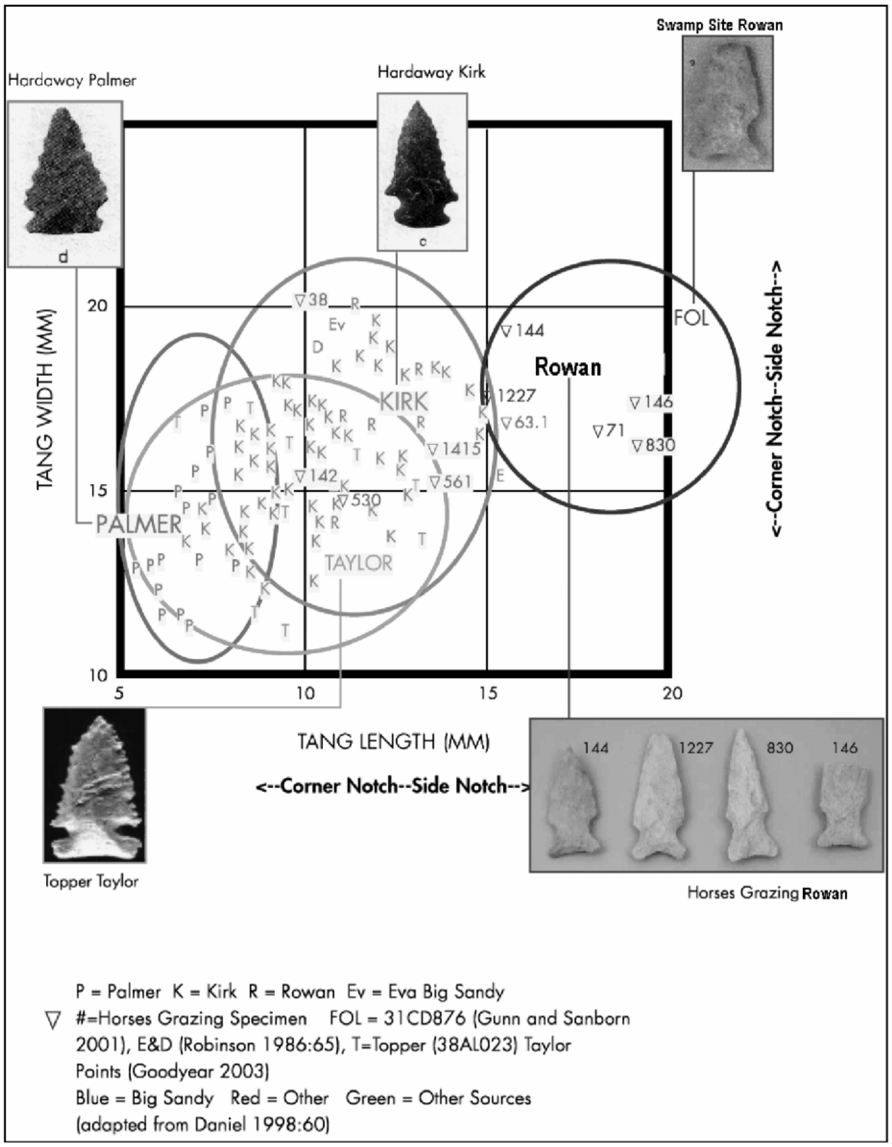

Figure 6. Tang length-width for notched points (adapted from Daniel 1998:60).

hunting ground rather than inhabited on a permanent basis. If such were the case, the makers of Taylor and Rowan points could have been the same people. They were just equipped for long-distance travel when they came to the Fayetteville-area Sandhills with their combination projectile-knife points. An alternative model would have been that they traveled from the Piedmont. This seems more likely as the animal migrations patterns would have shifted from north–south in the Pleistocene (glacier to southern coasts) to east–west (mountains to coast) in the Holocene.

The implications of functional morphology, breakage, and refabrication can largely be read from Table 1. There are relatively few point fragments (5 bases, 2 blades, and 15 tips) compared to the points (n=47). The relatively large number of tips suggests that they were brought to the camp in game and discarded when found during consumption. The few blades suggest that little extraordinarily vigorous uses were made of points (i.e., no butchery of big game on site, no surprise). These uses seem to have declined over time even though site activity increased, perhaps as attention turned to smaller game such as turtles and fish. The long persistence of point technological traditions such as shafting the tip and grinding the bases leads one to suspect persistence of populations, at least until Early Woodland times. This need not be the case, however, as useful means of making implements can readily be reinvented or even copied from field losses of earlier traditions.

Table 4 is sorted to show the shortest lived traditions on the left and longer lived traditions on the right. Shafting the tip is the longest tradition, extending from Early Archaic to Late Woodland. Grinding of the haft and base are nearly equally as enduring. On the other hand, making points with robust blades and thinned bases fades by Middle Archaic times, and beveling is equally short lived. The fading of these traditions probably signals the end of large game hunting by inhabitants of the site.

Of course, another question is why were most of the carefully engineered Rowan points left unbroken at Horses Grazing? Or is travel the answer here as well? Suppose Crane Creek was such a good wetland that they knew they would return, so they cached the points at the site. Four of the points near the west end of Block 1 were scattered up through the profile. This and other indications suggest a disturbance in the western area of Block 1 and eastern Block 5 in preceramic times. It could have been a tree tilt or the result of human activity. That the points are all in near horizontal proximity may indicate that they were left together in a single package.

Table 4. Persistence of Technological Traditions at Horses Grazing by Frequencies.

Description	Size	ThickBa-ThinBl	Beveling	Binding Notches	Serration	Backing	Shafted Tip	Grind base	Grind haft	Grind blade
Big Sandy		1					1	2	1	
Big Sandy			1				1	3	3	1
Big Sandy		1						2	1	
Big Sandy		1					1	2	2	
Big Sandy		1	1					1	1	
Kirk Serrated	l			1	1		1	1	1	
Kirk Coner Notched	s						1	1	1	
Kirk Knife	v							1	1	
Kirk Serrated	s		1			1	2	1	1	
Stanly	l	1	1	1			1	2	2	
Stanly	s	1			1		1		1	
Morrow Mountain Drill	l		1	1				1		
Morrow Mountain	s	1								
Morrow Mountain	s			1			1	1	1	
Morrow Mountain	s	1		1			2	1	1	
Morrow Mountain	s				1		2		1	1
Morrow Mountain	s			1			1	3	3	
Morrow Mountain	s			1				1	1	
Morrow Mountain	s			1			1		1	
Morrow Mountain				1			2	1	1	
Morrow Mountain	s			1				1	1	
Guilford Crude Round	s					1				2
Guilford Crude Round	s						1			
Guilford Crude Round	s							1	1	3
Guilford Crude Straight	v									
Guilford Crude Straight									1	
Guilford Refined Round	s							2		
Guilford Refined Round	s							1	1	1
Guilford Refined Straight	s							1	1	
Guilford Refined Straight	s								1	
Guilford Refined Straight	s				1			2	2	1

Table 4 continued.

Description	Size	ThickBa-ThinBl	Beveling	Binding Notches	Serration	Backing	Shafted Tip	Grind base	Grind haft	Grind blade
Savannah River										
Savannah River								1		
Savannah River	1								2	
Savannah River										
Savannah River Small								1	1	
Savannah River Small								1	1	
Eared Yadkin								1		
Pee Dee Triangular							1			

Point Morphology: Organizing Points by Stylistic Forms

In the previous section, the points from Horses Grazing were discussed in terms of established point terminology. This terminology was developed by Coe and other early archaeologists in the Southeast, and elaborated in the years since by still others (Cooper 1970; McAvoy and McAvoy 1997; Michie 1966; Oliver 1985). The fact that the Rowan variant of Big Sandy has largely escaped attention during the last 30 years can be attributed to several causes. As Cooper points out in his original type definition, they are widely but sparsely distributed. Even so, they appear in most collections "lumped with various side-notched and corner- notched types despite their distinctive morphology and technological differences" (Cooper 1970:114). What other types and their peculiar implications lay under the veil of existing terminology?

A means of opening investigations into new subsets of existing data is to attempt to gain new perspectives such as can be revealed by unbiased analysis. Avenues to new perspectives and unbiased analysis often arise from new technologies that free researchers of existing preconceptions. One such technology that has been broadly applied in many areas ranging from the study of satellite images of earth surfaces to the study of microscopic phytoliths is automatic measurement followed by pattern recognition analysis. Rovner has used a program (Prism: Image Analysis & Measurement Program, from Analytical Vision, Inc., Raleigh, NC) to automatically characterize phytoliths and, following the 1999 Uwharrie Lithic conference, expanded the technique to the study of lithic debitage. With this measurement technique, a program evaluates a digitized image taken from a scanner, video, or still camera, and performs a wide range of measurements on each object in the field of vision. The measurements range from relatively straight forward, such as measuring the area of each object, to quite elaborate, such as convexity, which is the ratio of the true distance around the object to the length of a rubber band stretched around the object (see Appendix A).

In this study, we wanted to bring about a clearer understanding of Rowan points relative to their morphological co-types. To do this, all of the points from Horses Grazing were measured. This is referred to as the "classification" collection (Figure 7). The classification collection also includes points from Daniel's (1998:54) "Other corner-notched points," "Kirks" from Claggett and Cable's (1982:461, Plate 12) Haw River sites, points from Copperhead Hollow (Gunn and Wilson 1993:130), and Rowans found by Robinson (site 31CD396 on the east Fayetteville Outer Loop, excavations sponsored by the North Carolina Department of Transportation and Wake Forest University).

To provide reference collections, examples were measured from several related sources: Daniel's (1998:51–57) discussions of points at Hardaway (Hardaway-Dalton, Hardaway Side-Notched, Kirk, Palmer), Cooper's

(1970:112) Rowan type collection from Granville and Rowan counties, Big Sandys from Eva in Tennessee (Lewis and Lewis 1961:38, Plate 7), Taylor points from the Topper site (Goodyear 2001:18), and Fort Nottaway points (McAvoy and McAvoy 1997:151).

We understand that any assemblage is a part of its immediate landscape. Hence, the Horses Grazing point morphology is unique to the wetland margin circumstances of eastern Moore County (Gunn et al. 2003). The mix of point morphologies at any other site would be inappropriate to this ecology. In ecological terms, it makes no sense to compare the morphologies from Horses Grazing with those from Hardaway, whose mix of points was clearly bent by its proximity to a major quarry and by the necessities incumbent on those living on an elevated, igneous ridge (Daniel 1998). However, in the interest of a common regional terminology for points, which is an entirely different problem, there is value in comparing implements from distant and ecologically unrelated places.

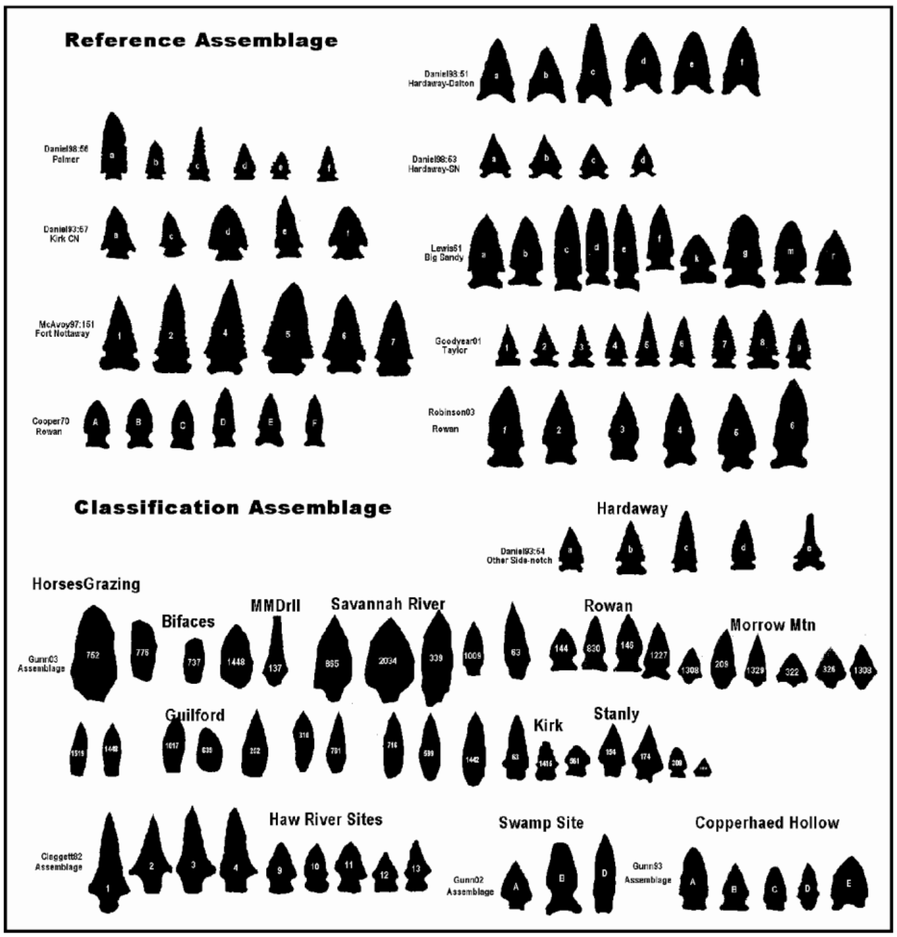

Figure 7. Point outline morphologies used in this study.

To this end, 115 points (i.e., 47 from Horses Grazing, and 68 from the other sources cited above) were treated by automatic measurement (see Figure 7). The reference collections represent those authors' views of what the types should look like as selected from large collections. The points included from Horses Grazing as well as from Gunn and Wilson, Claggett and Cable, and Robinson are target collections to be classified relative to the reference collections. However, none of the collections were singled out to be entered into the analysis as unclassified points. In this way, the entire array of point shapes is interactively involved in a process of defining shape variations of points in the North Carolina Piedmont/Coastal Plain region. The question is, how do the points as a shape population fit together in terms of our ideas of the total range of potential shapes, and how does the existing terminology correspond to parts of that range? There are important questions about the relationship between the total shape space and the parts defined as types. Are there parts of that space that have points but are empty of ideas? These would be potential new types. Do the existing ideas about point types define discrete areas of that space? An important perspective to keep in mind is that this analysis only deals with outline morphology, not other dimensions of point manufacture that are commonly referenced in type descriptions such as edge preparation, beveling, and material selection. In this study, adding the weight or mass of the points, a future undertaking, would have added considerably to the completeness of the descriptions.

To perform the measurements, each point was converted to a binary image; the points were made all black surrounded by white (see Figure 7), and measured by 28 methods such as those described above. To provide an indication of how well the various measures performed relative to the existing point typology, a variable was included with the names of the standard types. A discriminant function routine (SPSS version 8.0) classified the points into the standard point types. Six measurements proved the most powerful descriptors (Tables 5, 6, and 7). “Curl” was the most important determinant of point type shape in combination with “Area,” “Breadth,” etc. The six measurements are discussed in Appendix A. Since the complex data collected by the program were unsupervised by human intervention, the data are unbiased apart from the preconceptions inherent in the programming.

Perhaps the more important part of this result from the perspective of as-yet-undiscovered types is what was not classified. If a pattern of points is found outside the territories marked by existing point types, does it represent an unrecognized type lying beyond the scope of the existing terminology? If an existing type is scattered across other type territories, does it represent an inconsistency within the terminology, or are non- measured dimensions involved? Maps of how the types lie on the most important dimensions are helpful in evaluating these questions. The first four dimensions account for most (92.61%) of the variation in the point measurements. We will map and discuss them to give a preview of what occurs in the six total dimensions.

Examination of the first map of type territories shows that several types—Fort Nottaway, Savannah River, Taylor, Guilford, and perhaps Hardaway—are strongly separated (Figure 8). The cross in the center of the territories we will call the “zeros.” Specimens clustered around the

Table 5. Discriminant Function Statistics: Variables Selected as Most Powerful Discriminators Between Types.

	Statistic	df1	df2	df3	Statistic	df1	df2	Sig.
Step					Exact F			<
1 Curl	0.348	1	11	99.0	16.843	11	99	0.000
2 Area	0.130	2	11	99.0	15.818	22	196	0.000
					Approximate F			
3 Breadth	0.068	3	11	99.0	12.919	33	286.5	0.000
4 Y-Cent. Grav.	0.037	4	11	99.0	11.491	44	369.2	0.000
5 Equiv. Diam.	0.024	5	11	99.0	9.9585	55	443.3	0.000
6 Convexity	0.017	6	11	99.0	8.8852	66	508.4	0.000

At each step, the variable that minimizes the overall Wilks’ Lambda is entered.
Maximum number of steps is 52.
Minimum partial F to enter is 3.84.
Maximum partial F to remove is 2.71.
F level, tolerance, or VIN insufficient for further computation.

Table 6. Discriminant Function Statistics: Variance Accounted for by the Functions.

Function	Eigenvalue	% of Variance	Cumulative %	Canonical Correlation
1	2.97	41.88	41.88	0.87
2	1.99	28.07	69.95	0.82
3	0.98	13.80	83.75	0.70
4	0.66	9.36	93.11	0.63
5	0.28	4.00	97.11	0.47
6	0.21	2.89	100.00	0.41

zeros are not related to the dimensions being mapped. The area around the zeros is a classification black hole. They may be classified on other dimensions, but the points around the zeros are not meaningful on the dimensions being plotted. The tighter and further away from the zeros the clusters are, the more coherent the type. Guilford, for example, has a close knit and largely discrete cluster some distance from the zeros. It clusters, as might be expected, near bifaces and small Savannah Rivers; a Morrow Mountain has also crept in among the Guilfords. However, as in the tang length-width plot discussed above (see Figure 6), Palmers and Kirks are

Table 7. Discriminant Function Statistics: Cross Classifications.

Type	1	2	3	4	5	6	7	8	9	10	11	12	Total
1 Hardaway Dalton (HD)	5		1										6
2 Hardaway Sidenotched (SN)	1	3				1							5
3 Big Sandy (Bi)	1	1	8										10
4 Taylor (Ta)				7		2							9
5 Rowan (Ro)	1		2		14		1		2	1			21
6 Palmer (Pa)		1	1	2	2	5							11
7 Kirk (Ki)		2	1	1	1	1	5		2	1		3	17
8 Nottaway (No)	1							5					6
9 Stanly (St)									2				2
10 Morrow Mountain (MM)		1			1				2	3	1		8
11 Guilford (Gu)					1						10		11
12 Savannah River (Sa)											2	3	5
Total	9	8	13	10	19	9	6	5	8	5	13	6	111

mixed and scattered among other types near the zeros. Rowans are also scattered around the zeros. Since we are dealing with six dimensions in all, they could be separated by other dimensions. How about dimensions 3 and 4?

Additional types—Hardaway, Morrow Mountain, Big Sandy, and Rowan to some extent—are separated by dimensions 3 and 4 (Figure 9). Palmer and Kirk also produce clusters off the zeros. Kirk, however, is widely scattered across Morrow Mountain and Hardaway territories and mixes with Palmer. Neither map achieves satisfactory separation of the Kirk type. This may be the ambiguous character of Kirk, a character that led Cable (1996:112) to argue for the abandonment of the Kirk Corner- Notched variety in favor of Palmer. However, there is an indication that a plot of dimensions 2 and 3 would clarify the Kirk picture some, a topic to be explored in another project.

Careful examination of plots of all six primary dimensions in various combinations might help discover which dimensions are discriminating Palmers and Kirks. However, how the types overlap in territories is clear in Table 7. Although not supplying the visual and spatial information of the plots, Table 7 will serve to help us understand the relationships between types for now. Table 7 shows the number of points of each type that was classified correctly on the diagonal and not correctly classified off the diagonal. The rectangle inside the table outlines the Early Archaic Big Sandy variants along with Kirk and Palmer. As can be seen, there are few

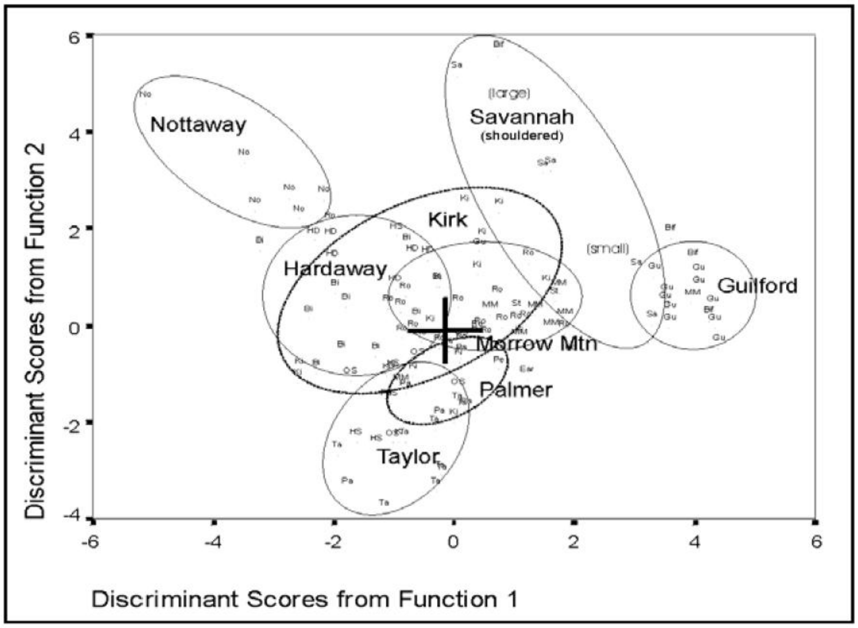

Figure 8. Type territory map of the first and second dimensions (69.95% of the variance).

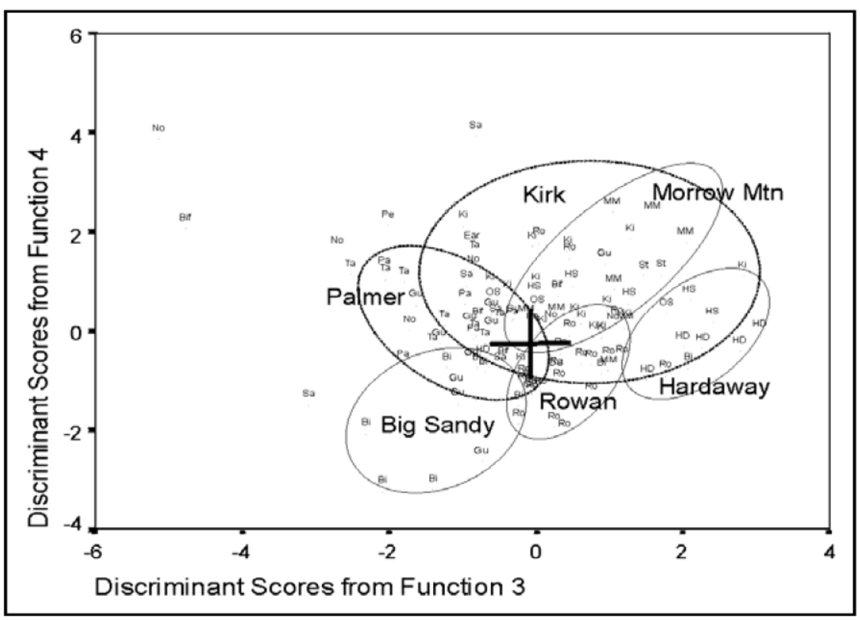

Figure 9. Territorial map of point types for the first four functions.

Table 8. Successful versus Unsuccessful Classifications of Early Archaic Side-notched Types.

Type	Successful	Unsuccessful	Percent Successful
Big Sandy	8	0	100
Nottaway	5	0	100
Taylor	7	2	78
Rowan	14	5	74
Palmer	5	5	50
Kirk	5	6	46
Total	45	18	

misclassifications outside the box, but many inside. Tabulating the classifications inside the box will focus our attention on the Early Archaic points (Table 8). Large proportions of the Big Sandy (100%), Nottaway (100%), Rowan (74%), and Taylor (78%) points were classified as expected. Palmers (50%) and Kirks (46%), however, proved more difficult. Particularly impressive is the confusion between Palmers and Kirks and most of the other types in both cases. Some of this confusion is explainable in terms of neglect of the Rowan type. In the Gunn and Wilson, and Claggett and Cable assemblages, and the Daniel (1998) "other side-notched points" category, Rowans are present. This accounts for three of the Rowans that were classified as Kirks. Are there other such missing types?

Returning to the original data (see Appendix A and Figure 7), it can be seen that all of Cooper's Rowans were correctly classified. Two of Goodyear's Taylors were classified as Palmers. One point from the Palmer reference collection (Daniel) was classified as a Taylor and the other a Big Sandy. All of this underscores the close outline-relationships between the types. Three of the five points in Daniel's Kirk reference collection were misclassified as Palmer, Big Sandy, and Hardaway Side- Notched. Similar problems are apparent among the points from Claggett and Cable, which were classified by the authors as Kirks. It was anticipated that one of the points would be classified as a Rowan. However, three of the Kirks were grouped with the Small Savannah Rivers and one as a Hardaway Side-Notched. These are classification problems similar to the issue raised by Drye (1998) of resharpening Savannah Rivers and Morrow Mountains till they look like Guilfords. Other such clues—clues that could inform subsequent analyses with large samples and more time to focus on the analysis of classifications—may exist in this table.

Conclusions

The strata of Horses Grazing contained a full-Holocene sequence of cultures, perhaps including some occupation during the Late Pleistocene. Technological traditions for making points were sustained in some features, such as shafting the tip and grinding the base, through the whole record. Other features, such as beveling the blade and making the blade thicker than the haft, were confined to the Early Archaic. Medium-sized bifaces commonly identified as Guilfords were found to be scattered through the Archaic levels. Only the Guilford refined round based form was confined to the Middle Archaic. That, however, is based on only two points. Using an automatic measuring technology and analyzing the data with discriminant function analysis, we found that as is generally recognized, it is difficult to separate Kirks and Palmers. The Big Sandy variants (Taylor, Rowan, Fort Nottaway), however, are often morphologically distinct from their notched contemporaries. The study was based strictly on outline shape, which ignores technological attributes except in so far as they are captured by the outline morphology.

The presence of a Big Sandy-Rowan component at the site raises questions about this little-studied point type and the people who made them. That there are two related varieties of Big Sandy to the south and north at differing time periods (Taylor points in South Carolina and Fort Nottaway in Virginia), but similar tool kits, suggests that perhaps the same culture moved up the Atlantic Slope in the tenth millennium B.P. There are plausible explanations for such a movement. The period was the transitional millennium between Pleistocene globally cold conditions and Holocene warm conditions. This suggests that isotherms would have been moving northward across the region.

Early and Middle Holocene climates would have required adapting to an extremely mobile game population in the case of the larger game such as elk and bison. Under strong seasonal pressure, large species tend to use their long legs to migrate to favorable seasonal reserves, to the mountain high pastures in summer and to the coastal lowlands in the winter. A number of worldwide examples of this pattern can be cited, such as wild cattle in the Palestine who were ambushed at Tabun, or the site of Ambrona-Torralba in the uplands of western Spain. In North Carolina, semiannual migrations between the Coastal Plain and highland areas such as Avery County, a high plateau north of Asheville, would have been likely patterns. The Fall Line-Sand Hills would have offered a location for ambushes as the migrating herds moved through the narrow valleys of the first dissected landscape inland from the coastal winter grazing areas.

In his book on the survey of the North Carolina-Virginia border in the eighteenth century, William Byrd (1967:236) reported that bison occurred south of 37 degrees latitude while elk were to the north. This is the Latitude of Newport News, Virginia. It suggests that the Big Sandy variants could represent a group (or groups) focused on bison hunting. The focus of their activity was in the South Carolina Savannah River area early on after Dalton during the Younger Dryas subpluvial. Dalton probably represents the terminal phase of the very large game hunting of elephants (Anderson 1995), while Big Sandy vars. was concerned with the medium-sized game that survived the collapse of the megafauna. This accounts for the peculiar similarity of the tool kits between Dalton and Big Sandy (Driskell 1996; McAvoy and McAvoy 1997). The interesting question is what was the change in stress factors that dictated a shift from the Dalton to Big Sandy morphology? The northward drift of the Big Sandy variants could be justified in terms of warming climate at the end of the Pleistocene. As the isotherm that defined the northern limit of the elk- bison range moved north, so did the Big Sandy variants. The final extension of their range was in southern Virginia with the Fort Nottaway variant near the northern range of the bison in the eighteenth century as reported by Byrd.

The location of the Horses Grazing site could be associated with the reported game migration trail between the mountains and the coast (Oates 1981). Brooks (personal communication 1995) has found that the routes of modern interstate highways were frequented by Paleoindians and probably represent megafaunal migration routes. Megafauna appear to have spent summers near the glaciers in the north and winters on the Gulf Coast (Guthrie 1978). As migration in the Holocene shifted 90 degrees to a coastal-mountain axis, the patterns of human movement and settlement would have followed suite. Rowan points appear to cluster near the Fall Line and near the Mountains, both at increases in topographic relief and increased opportunity for ambushes. This adaptation would have yielded a pattern of the sort suggested by Daniel (1998) in his analysis of lithics during the late Paleoindian-Early Archaic periods and would have coincided with major streams along the Atlantic Slope rather than crossing them.

The evidence of Big Sandy variant bands focused on bison hunting and movement with isotherms is circumstantial. As has been pointed out in the past, direct evidence of bison hunting remains elusive in the Southeast east of the mountains because of lack of osteological evidence. There are a number of reason why osteological evidence might be the absent. The bones were unlikely to be carried to camps because of their weight. Even the Plain Indians who had horses stripped the bison meat and carried only the dried meat to camp. The Shoshone Indians of the Great Basin made trips on foot to the Plains to hunt bison, and certainly striped the meat and dried it before carrying it back to the Basin for the winter (Stewart 1938). The bones would have been at the time of consumption 500 miles distant. Also, bison bones are often mistaken for cattle bones. Bison bones and any other bones are unlikely to have survived the acidic soil environment of the Sandhills, even in the unlikely event they were taken to camp. Other means of approaching this problem need to be sought such as residue analysis and hair traces in flotation samples.

Acknowledgments

The authors would like to thank the many archaeologists who provided data and other assistance with this article. Ken Robinson has encountered similar problems at 31CD396 and was a party to the discussions throughout. Albert C. Goodyear, Tommy Charles, and Joe McAvoy supplied data and invaluable insights to related Rowan variants. Randy Daniel was helpful with concepts, and his formulations of the Early Archaic point types from his book on Hardaway formed the central core of the consideration of point morphology. The senior author was attending graduate school at the University of Kansas when Pete Cooper was formulating his concept of the Rowan point type, published in 1970. Although I have no specific recollections of those deliberations, the many hours spent with Pete, discussing mostly World War II, are all recalled with the greatest respect and pleasure.

J.J. Barnes, on whose property the Horses Grazing site was located, was generous with his time and knowledge of the area around the site, including a tour of a massive, once commercially exploited, quartz quarry a few hundred meters downstream from the site. He also provided extremely useful on-site accommodations for the crew and equipment. The project was sponsored by the North Carolina Department of Transportation (TIP R-210, Federal Aid No. NHS 0001(3), State Project 8.T560302, Improvements to US Highway 1, Moore County, Division 8).

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APPENDIX A

Variables Used in Discriminant Analysis

Morphometric analysis and expert vision systems are a promising approach to unbiased analysis of artifact forms (Rovner 1995; Russ 1990; Russ and Rovner 1989). The six most powerful classifiers of point shapes by automatic measurements, from a list of 28, are discussed below. This is followed by the data for those measurements accompanied by the discriminant scores for the points. The discriminant scores are plotted in the last two figures.

Curl is a measure of departure from a straight line or a measure of asymmetry. It is the length divided by the "skeleton's" center line. If an object is "long" and symmetrical, then the length and the center line are the same. If an object is asymmetrical, the center line will deviate from a straight line and becomes longer in ratio to length. Curl is obtained by dividing length by center line distance, which arbitrarily gives values of 1.0 or less. Length is not the vertical axis of a point, but the longest distance, from the corner of a tang to the tip on a side-notched point, but through the vertical axis on a Morrow Mountain. This variation in measurement from normal archaeological measurement procedures probably explains why curl is such a powerful descriptor. It is an example of the serendipitous findings than can emerge from unbiased investigations. It deserves further consideration.

Area is straightforward size.
Breadth is the width of a box needed to contain the object into. It is equivalent to "maximum" width.
Y-Center of Gravity is the center of gravity along the vertical axis of the object.
Equivalent Diameter is the diameter of a circle having the same area as an irregular object.
Convexity is a shape measure of irregularity. It is the ratio of true perimeter divided by the length of a "taut string" or rubber band placed around the outside of the object. An irregular object has a longer true perimeter than the size of the polygon it fits into. It would, for example, discriminate between straight and serrated edges.

Table A1. Measurements on Points and Discriminate Scores.

Sequence	Ref-Class	Plate	Type Map Symbol	TypeN	Label
1	classification	01Gunn	Bif	0	biface
2	classification	01Gunn	Bif	0	biface
3	classification	01Gunn	Bif	0	biface
4	classification	01Gunn	Bif	0	biface
5	classification	01Gunn	MM	10	MMdrill
6	classification	01Gunn	MM	10	MMG03
7	classification	01Gunn	MM	10	MMG03
8	classification	01Gunn	MM	10	MMG03
9	classification	01Gunn	MM	10	MMG03
10	classification	01Gunn	MM	10	MMG03
11	classification	01Gunn	MM	10	MMG03
12	classification	01Gunn	Ro	5	RowanG03
13	classification	01Gunn	Ro	5	RowanG03
14	classification	01Gunn	Ro	5	RowanG03
15	classification	01Gunn	Ro	5	RowanG03
16	classification	01Gunn	Sa	12	SavRivG03
17	classification	01Gunn	Sa	12	SavRivG03
18	classification	01Gunn	Sa	12	SavRivG03
19	classification	01Gunn	Sa	12	SavRivG03
20	classification	01Gunn	Sa	12	SavRivG03
21	classification	02Gunn	Ear	13	EaredYadG03
22	classification	02Gunn	Gu	11	GuilfordG02
23	classification	02Gunn	Gu	11	GuilfordG02
24	classification	02Gunn	Gu	11	GuilfordG02
25	classification	02Gunn	Gu	11	GuilfordG02
26	classification	02Gunn	Gu	11	GuilfordG02
27	classification	02Gunn	Gu	11	GuilfordG02
28	classification	02Gunn	Gu	11	GuilfordG02
29	classification	02Gunn	Gu	11	GuilfordG02
30	classification	02Gunn	Gu	11	GuilfordG02
31	classification	02Gunn	Gu	11	GuilfordG02
32	classification	02Gunn	Ki	7	KirkG03
33	classification	02Gunn	Ki	7	KirkG03
34	classification	02Gunn	Pe	13	PeeDeeG03
35	classification	02Gunn	Ro	5	RowanG03
36	classification	02Gunn	St	9	StanlyG03
37	classification	02Gunn	St	9	StanlyG03
38	classification	03Claggett	Ki	7	KirkC82
39	classification	03Claggett	Ki	7	KirkC82
40	classification	03Claggett	Ki	7	KirkC82
41	classification	03Claggett	Ki	7	KirkC82
42	classification	03Claggett	Ki	7	KirkC82
43	classification	03Claggett	Ki	7	KirkC82
44	classification	03Claggett	Ki	7	KirkC82
45	classification	03Claggett	Ki	7	KirkC82

Table A1 continued.

Sequence	Ref-Class	Plate	Type Map Symbol	TypeN	Label
46	classification	03Claggett	Ki	7	KirkC82
47	reference	04Cooper	Ro	5	Rowan
48	reference	04Cooper	Ro	5	Rowan
49	reference	04Cooper	Ro	5	Rowan
50	reference	04Cooper	Ro	5	Rowan
51	reference	04Cooper	Ro	5	Rowan
52	reference	04Cooper	Ro	5	Rowan
53	reference	05Daniel	HD	1	Hard-Dalt
54	reference	05Daniel	HD	1	Hard-Dalt
55	reference	05Daniel	HD	1	Hard-Dalt
56	reference	05Daniel	HD	1	Hard-Dalt
57	reference	05Daniel	HD	1	Hard-Dalt
58	reference	05Daniel	HD	1	Hard-Dalt
59	reference	06Daniel	HS	2	Hard-SN
60	reference	06Daniel	HS	2	Hard-SN
61	reference	06Daniel	HS	2	Hard-SN
62	reference	06Daniel	HS	2	Hard-SN
63	classification	07Daniel	OS	6	OtherSN
64	classification	07Daniel	OS	6	OtherSN
65	classification	07Daniel	OS	6	OtherSN
66	classification	07Daniel	OS	6	OtherSN
67	classification	07Daniel	OS	6	OtherSN
68	reference	08Daniel	Pa	6	Palmer
69	reference	08Daniel	Pa	6	Palmer
70	reference	08Daniel	Pa	6	Palmer
71	reference	08Daniel	Pa	6	Palmer
72	reference	08Daniel	Pa	6	Palmer
73	reference	08Daniel	Pa	6	Palmer
74	reference	09Daniel	Ki	7	Kirk CN
75	reference	09Daniel	Ki	7	Kirk CN
76	reference	09Daniel	Ki	7	Kirk CN
77	reference	09Daniel	Ki	7	Kirk CN
78	reference	09Daniel	Ki	7	Kirk CN
79	reference	10Goodyear	Ta	4	Taylor
80	reference	10Goodyear	Ta	4	Taylor
81	reference	10Goodyear	Ta	4	Taylor
82	reference	10Goodyear	Ta	4	Taylor
83	reference	10Goodyear	Ta	4	Taylor
84	reference	10Goodyear	Ta	4	Taylor
85	reference	10Goodyear	Ta	4	Taylor
86	reference	10Goodyear	Ta	4	Taylor
87	reference	10Goodyear	Ta	4	Taylor
88	classification	11Gunn	HS	2	HardawaySNG93
89	classification	11Gunn	MM	10	MMG93
90	classification	11Gunn	Ro	5	RowanG93

Table A1 continued.

Sequence	Ref-Class	Plate	Type Map Symbol	TypeN	Label
91	classification	11Gunn	Ro	5	RowanG93
92	classification	11Gunn	Ro	5	RowanG93
93	classification	12Gunn	Gu	11	GuilfordG93
94	classification	12Gunn	Ki	7	KirkSTG93
95	classification	12Gunn	Ro	5	RowanG93
96	reference	13Lewis	Bi	3	Big Sandy
97	reference	13Lewis	Bi	3	Big Sandy
98	reference	13Lewis	Bi	3	Big Sandy
99	reference	13Lewis	Bi	3	Big Sandy
100	reference	13Lewis	Bi	3	Big Sandy
101	reference	13Lewis	Bi	3	Big Sandy
102	reference	13Lewis	Bi	3	Big Sandy
103	reference	13Lewis	Bi	3	Big Sandy
104	reference	13Lewis	Bi	3	Big Sandy
105	reference	13Lewis	Bi	3	Big Sandy
106	reference	14McAvoy	No	8	Nottaway
107	reference	14McAvoy	No	8	Nottaway
108	reference	14McAvoy	No	8	Nottaway
109	reference	14McAvoy	No	8	Nottaway
110	reference	14McAvoy	No	8	Nottaway
111	reference	14McAvoy	No	8	Nottaway
112	reference	15Robinson	Ro	5	Rowan
113	reference	15Robinson	Ro	5	Rowan
114	reference	15Robinson	Ro	5	Rowan
115	reference	15Robinson	Ro	5	Rowan
116	reference	15Robinson	Ro	5	Rowan
117	reference	15Robinson	Ro	5	Rowan

Appendix 1 continued.

Sequence	Predicted Type(if different)	Predicted TypeN	p P(D>d | G=g)	df	P(G=g | D=d)	Squared Mahalanobis Distance to Centroid
1		12	0.000	6	0.98	34.27
2		11	0.865	6	0.97	2.53
3		11	0.420	6	0.72	6.02
4		11	0.961	6	0.99	1.48
5	Gu	11	0.930	6	0.99	1.88
6		10	0.910	6	0.53	2.10
7	St	9	0.874	6	0.73	2.45
8	Ro	5	0.971	6	0.63	1.31
9	St	9	0.970	6	0.81	1.33
10		10	0.393	6	0.64	6.28
11	HS	2	0.619	6	0.90	4.43
12		5	0.927	6	0.58	1.92
13		5	0.654	6	0.49	4.16
14		5	0.875	6	0.77	2.44
15	St	9	0.741	6	0.50	3.52
16	Gu	11	0.976	6	0.90	1.21
17		12	0.145	6	0.99	9.55
18		12	0.001	6	0.72	22.01
19		12	0.981	6	1.00	1.12
20	Gu	11	0.967	6	0.90	1.38
21		10	0.119	6	0.65	10.13
22		11	0.875	6	0.97	2.44
23		11	0.955	6	0.99	1.57
24		11	0.743	6	1.00	3.50
25		11	0.900	6	1.00	2.21
26		11	0.404	6	0.82	6.17
27		11	0.963	6	0.96	1.45
28		11	0.948	6	0.99	1.66
29		11	1.000	6	0.98	0.19
30		11	1.000	6	0.97	0.26
31		11	0.994	6	0.98	0.72
32	St	9	0.872	6	0.35	2.47
33	MM	10	0.879	6	0.62	2.40
34		6	0.000	6	0.66	44.85
35	MM	10	0.218	6	0.43	8.29
36		9	1.000	6	0.74	0.27
37		9	1.000	6	0.65	0.27
38	Sa	12	0.331	6	0.65	6.89
39	Sa	12	0.370	6	0.65	6.50
40	Sa	12	0.290	6	0.88	7.35
41		7	0.292	6	0.78	7.32
42	Ro	5	0.976	6	0.40	1.22
43		7	0.913	6	0.52	2.07

Appendix 1 continued.

Sequence	Predicted Type(if different)	Predicted TypeN	p P(D>d | G=g)	df	P(G=g | D=d)	Squared Mahalanobis Distance to Centroid
44		7	0.972	6	0.53	1.29
45		7	0.846	6	0.32	2.69
46	HS	2	0.931	6	0.34	1.88
47		5	0.778	6	0.60	3.24
48		5	0.944	6	0.74	1.72
49		5	0.964	6	0.62	1.44
50		5	0.871	6	0.71	2.48
51		5	0.810	6	0.42	2.99
52		5	0.899	6	0.70	2.22
53	Bi	3	0.607	6	0.45	4.52
54		1	0.989	6	0.96	0.92
55		1	0.813	6	0.93	2.97
56		1	0.981	6	0.96	1.12
57		1	0.914	6	0.99	2.06
58		1	0.992	6	0.94	0.80
59		2	0.553	6	0.55	4.93
60		2	0.980	6	0.86	1.13
61		2	0.986	6	0.90	1.00
62	Pa	6	0.467	6	0.46	5.62
63		5	0.976	6	0.60	1.22
64		4	0.498	6	0.74	5.37
65		6	0.980	6	0.45	1.12
66		2	0.976	6	0.80	1.22
67		5	0.957	6	0.42	1.54
68	Bi	3	0.195	6	0.30	8.65
69		6	0.995	6	0.57	0.68
70		6	0.903	6	0.70	2.18
71		6	0.758	6	0.77	3.40
72		6	0.299	6	0.84	7.24
73	Ta	4	0.143	6	0.82	9.58
74		4	0.067	6	0.45	11.79
75	Pa	6	0.929	6	0.41	1.89
76	Bi	3	0.801	6	0.29	3.06
77		7	0.147	6	0.60	9.52
78	HS	2	0.406	6	0.58	6.15
79		4	0.820	6	0.92	2.91
80		4	0.699	6	0.97	3.84
81	Pa	6	0.286	6	0.50	7.39
82		4	0.368	6	0.97	6.52
83	Pa	6	0.994	6	0.61	0.72
84		4	0.986	6	0.49	0.98
85		4	0.942	6	0.92	1.74
86		4	0.243	6	0.87	7.94

Appendix 1 continued.

Sequence	Predicted Type(if different)	Predicted TypeN	p P(D>d | G=g)	df	P(G=g | D=d)	Squared Mahalanobis Distance to Centroid
87		4	0.763	6	0.61	3.35
88	HB	1	0.627	6	0.77	4.37
89		10	0.977	6	0.54	1.19
90		5	0.688	6	0.49	3.91
91	St	9	0.574	6	0.53	4.77
92		5	0.724	6	0.41	3.65
93	Ro	5	0.151	6	0.70	9.44
94	St	9	0.370	6	0.92	6.50
95	HD	1	0.375	6	0.57	6.45
96		3	0.906	6	0.94	2.14
97		3	0.998	6	0.82	0.51
98		3	0.425	6	0.93	5.99
99		3	0.174	6	0.97	9.00
100		3	0.337	6	0.85	6.83
101		3	0.973	6	0.68	1.27
102	HS	2	0.548	6	0.52	4.97
103		3	0.379	6	0.64	6.41
104		3	0.840	6	0.77	2.75
105	HD	1	0.918	6	0.82	2.02
106		8	0.000	6	1.00	29.53
107		8	0.928	6	1.00	1.91
108		8	0.942	6	0.99	1.74
109		8	0.972	6	1.00	1.30
110	HD	1	0.678	6	0.86	3.99
111		8	0.425	6	0.66	5.99
112	Bi	3	0.945	6	0.64	1.70
113		5	0.881	6	0.55	2.39
114		5	0.691	6	0.56	3.90
115		5	0.926	6	0.57	1.93
116	Ki	7	0.684	6	0.50	3.94
117	Bi	3	0.851	6	0.46	2.65

Appendix 1 continued.

Sequence	Curl	Area	Breadth	Y-Cent.Grav.	Equiv. Diam.	Convexity
1	1.00	25.05	4.05	30.09	5.65	0.95
2	1.00	10.07	2.40	30.65	3.58	0.96
3	1.00	11.86	2.90	30.36	3.89	0.95
4	1.00	6.22	1.90	30.11	2.81	0.96
5	0.98	7.86	2.30	30.65	3.16	0.95
6	0.94	5.75	2.59	15.65	2.70	0.94
7	0.98	5.63	2.40	15.41	2.68	0.94
8	0.89	8.27	2.60	13.21	3.25	0.92
9	1.00	8.09	2.40	12.87	3.21	0.94
10	0.96	4.19	2.18	11.74	2.31	0.94
11	0.77	5.03	2.67	11.55	2.53	0.89
12	0.91	7.10	2.35	15.27	3.01	0.93
13	0.86	6.52	2.50	14.85	2.88	0.92
14	0.90	8.73	2.55	13.90	3.33	0.93
15	0.99	5.48	2.05	13.45	2.64	0.94
16	1.00	10.10	2.32	23.26	3.59	0.95
17	1.00	17.71	2.85	21.91	4.75	0.95
18	1.00	22.24	4.45	21.66	5.32	0.94
19	1.00	16.94	3.35	21.35	4.64	0.94
20	1.00	6.37	1.90	22.74	2.85	0.95
21	0.94	3.49	1.75	13.12	2.11	0.93
22	1.00	9.70	2.45	31.05	3.51	0.95
23	1.00	7.71	2.14	30.96	3.13	0.95
24	1.00	5.48	1.68	30.43	2.64	0.95
25	1.00	6.12	1.75	30.44	2.79	0.96
26	1.00	7.16	2.45	30.57	3.02	0.96
27	1.00	10.22	2.20	25.02	3.61	0.95
28	1.00	8.12	1.90	25.07	3.22	0.96
29	1.00	8.13	2.00	24.90	3.22	0.95
30	1.00	7.26	2.00	25.29	3.04	0.95
31	1.00	6.48	1.85	24.87	2.87	0.95
32	0.97	8.64	2.45	14.02	3.32	0.94
33	0.93	5.05	2.09	13.07	2.54	0.94
34	0.92	1.76	1.53	15.92	1.50	0.96
35	0.88	4.54	2.30	13.23	2.40	0.94
36	0.98	7.24	2.46	13.95	3.04	0.94
37	0.93	7.84	2.73	13.62	3.16	0.92
38	0.92	15.83	3.74	21.12	4.49	0.91
39	0.88	15.95	3.61	21.20	4.51	0.89
40	0.91	17.97	3.85	19.84	4.78	0.89
41	0.85	13.54	3.79	20.74	4.15	0.88
42	0.88	7.28	2.47	7.66	3.05	0.90
43	0.79	9.46	3.01	7.69	3.47	0.85
44	0.87	9.27	2.87	7.54	3.44	0.89
45	0.89	7.77	2.38	7.53	3.14	0.89

Appendix 1 continued.

Sequence	Curl	Area	Breadth	Y-Cent.Grav.	Equiv. Diam.	Convexity
46	0.83	6.23	2.51	7.12	2.82	0.89
47	0.86	9.37	2.60	14.16	3.45	0.90
48	0.91	8.30	2.31	13.94	3.25	0.92
49	0.89	8.70	2.52	14.10	3.33	0.91
50	0.93	9.49	2.25	5.47	3.48	0.92
51	0.86	8.55	2.80	5.16	3.30	0.91
52	0.92	6.66	1.99	5.20	2.91	0.92
53	0.87	14.90	3.27	13.06	4.36	0.89
54	0.84	11.84	3.52	12.57	3.88	0.91
55	0.80	10.11	3.57	12.25	3.59	0.90
56	0.83	13.87	3.58	4.97	4.20	0.90
57	0.81	13.22	3.84	4.88	4.10	0.90
58	0.82	12.91	3.62	4.93	4.05	0.89
59	0.71	6.87	2.98	10.97	2.96	0.82
60	0.77	7.25	3.14	10.85	3.04	0.87
61	0.76	5.50	2.79	10.53	2.65	0.87
62	0.75	4.14	2.40	6.29	2.30	0.86
63	0.87	8.58	2.43	10.19	3.30	0.90
64	0.74	8.82	2.89	10.14	3.35	0.81
65	0.85	6.40	2.37	10.20	2.85	0.88
66	0.77	7.51	3.04	4.84	3.09	0.86
67	0.86	7.63	2.39	4.88	3.12	0.89
68	0.87	11.56	2.54	10.45	3.84	0.86
69	0.82	5.69	2.15	9.43	2.69	0.87
70	0.87	4.72	1.93	9.19	2.45	0.89
71	0.85	4.52	2.07	4.45	2.40	0.90
72	0.83	3.75	2.01	4.25	2.19	0.90
73	0.75	3.16	1.93	4.22	2.01	0.84
74	0.74	9.22	3.15	11.52	3.43	0.80
75	0.82	6.15	2.38	11.18	2.80	0.86
76	0.82	9.42	2.66	5.16	3.46	0.86
77	0.72	12.89	3.61	4.89	4.05	0.80
78	0.72	11.67	3.59	4.85	3.85	0.82
79	0.74	5.04	2.51	15.83	2.53	0.83
80	0.73	4.38	2.24	15.79	2.36	0.83
81	0.80	4.36	2.22	15.68	2.36	0.89
82	0.77	4.77	1.93	4.09	2.46	0.81
83	0.84	6.00	2.16	10.42	2.76	0.88
84	0.80	5.95	2.26	10.35	2.75	0.86
85	0.80	4.68	1.97	10.15	2.44	0.84
86	0.72	9.75	2.86	4.64	3.52	0.79
87	0.81	7.05	2.17	4.52	3.00	0.84
88	0.90	12.33	3.43	6.28	3.96	0.92
89	0.95	6.61	2.18	14.82	2.90	0.93
90	0.95	11.76	2.68	15.64	3.87	0.93

Appendix 1 continued.

Sequence	Curl	Area	Breadth	Y-Cent.Grav.	Equiv. Diam.	Convexity
91	0.97	5.69	2.09	14.98	2.69	0.92
92	0.85	7.60	2.70	14.73	3.11	0.91
93	1.00	11.29	2.12	4.19	3.79	0.95
94	0.95	7.93	2.81	3.16	3.18	0.93
95	0.85	14.90	3.35	3.89	4.36	0.91
96	0.79	14.81	3.30	2.98	4.34	0.84
97	0.83	12.90	3.09	3.03	4.05	0.87
98	0.90	12.65	2.34	3.74	4.01	0.88
99	0.93	14.34	2.45	3.66	4.27	0.92
100	0.93	11.61	2.19	3.94	3.85	0.92
101	0.83	9.87	2.60	2.79	3.55	0.87
102	0.73	10.27	3.24	4.69	3.62	0.84
103	0.78	17.21	3.79	3.16	4.68	0.86
104	0.80	12.37	2.99	2.91	3.97	0.84
105	0.82	11.04	3.31	2.61	3.75	0.89
106	0.83	28.06	4.90	4.68	5.98	0.85
107	0.86	22.55	4.20	3.93	5.36	0.87
108	0.86	19.44	3.77	3.78	4.98	0.88
109	0.82	19.44	4.16	3.50	4.97	0.86
110	0.84	16.14	3.87	3.39	4.53	0.89
111	0.89	17.03	3.69	3.07	4.66	0.90
112	0.87	10.56	2.64	2.79	3.67	0.90
113	0.89	8.39	2.49	2.75	3.27	0.90
114	0.92	6.91	2.15	2.50	2.97	0.91
115	0.89	8.22	2.35	3.09	3.24	0.90
116	0.88	9.81	2.70	2.70	3.53	0.88
117	0.90	11.41	2.70	3.39	3.81	0.90